



# Newsletter

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## Director's Note

The Hubbard Brook Ecosystem Study includes investigators whose research interests span a full range of habitats — groundwater, streams and lakes, soil, oldfields, hardwood forests — as well as air quality and meteorology. Most of the research is long-term, which means that data are collected continuously, year after year. Because change is best measured when compared to baseline information, and because ecosystem recovery after disturbance may happen over decades and centuries rather than months and years, it is the long-term nature of the Hubbard Brook research that makes it especially important in understanding environmental change.

I am very fortunate to have the Hubbard Brook Valley as one of my field study sites, and to be able to pursue my own long-term ecological and biogeochemical studies there. The feature story in this issue of the IES Newsletter describes some of the unique aspects of the Hubbard Brook Ecosystem Study.

The IES Newsletter is published by the Institute of Ecosystem Studies at the Mary Flagler Cary Arboretum. Located in Millbrook, New York, the Institute is a division of The New York Botanical Garden. All newsletter correspondence should be addressed to the editor.

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## One of the Most Intensely Studied Landscapes on Earth

Physicians monitor the health of their patients by taking samples of blood and urine — fluids that carry away waste products of human metabolism — and analyzing them for the chemicals they contain. In 1963, ecologist Dr. Gene E. Likens (then with Dartmouth College, N.H. and now director of the Institute of Ecosystem Studies) with colleagues Dr. F. Herbert Bormann (then at Dartmouth College and now at Yale University), Dr. Robert S. Pierce (U.S. Forest Service, now deceased) and Dr. Noye M. Johnson (Dartmouth College, now deceased) asked themselves if streams that flow through a forest ecosystem function in an analogous way ... if analysis of stream water chemistry would provide clues to the "health" of the surrounding forest. The scientists developed a research program, the Hubbard Brook Ecosystem Study (HBES), to address this question.

They named the program for the site they chose, the Hubbard Brook Experimental Forest in West Thornton, New Hampshire. In 1955 the U.S. Forest Service had set aside a parcel of White Mountain wilderness, a valley between adjacent mountains, for studies to assess the effects of human activities on forest ecosystems. The valley had several small, well-defined watersheds — each a tributary to Hubbard Brook — and nearly water-tight bedrock. Because the latter minimizes deep seepage, the site was ideal for monitoring stream chemistry, as almost all the water entering and flowing out of the ecosystem could be accounted for. The scientists set up precipitation collectors at more than a dozen locations to record input, and constructed a V-notch weir at the base of each watershed, enabling precise measurement of output.

Now, thirty years later, Hubbard Brook is one of the most intensely studied landscapes on Earth. Research by scientists from the Institute of Ecosystem Studies, the U.S. Forest Service and a number of universities and government agencies goes on year-round, with labs and research sites busiest during the summer field season. The longest continuous record of precipitation chemistry in North America is a product of the HBES, and it was HBES data gathered and analyzed by Dr. Likens and colleagues that provided the first evidence of acid rain in North America. The large Hubbard Brook site also makes "whole-ecosystem"

level experimental research possible. In one of the most significant applications of this technique, a commercial whole-tree harvest was done in one of the watersheds. Investigators found that large amounts of nutrients were lost in water running from the deforested slopes, and that the increase in nitrification and decomposition of organic matter in the soil caused increased acidity and trace metal amounts in stream water. With regrowth of vegetation over time, the chemistry of stream water began to return to normal. These findings have direct relevance to forestry practices such as clear-cutting.



*HBES research assistant Scott Nolan replacing bags on a device used to collect ambient precipitation as part of a throughfall study. (Throughfall is water that passes through the forest canopy.)*

Dr. Likens spends at least a month at Hubbard Brook each summer pursuing his long-term ecological studies and collaborating with his graduate students and scientific colleagues on other projects. This year he and Dr. Charles T. Driscoll of Syracuse University have begun a study of the ecological fate of trifluoroacetate (TFA). The 1990 Amendments to the Clean Air Act call for a complete phase out of chlorofluorocarbons (CFCs), the chemicals that have been used as aerosol propellants and refrigerants and are responsible for

*continued on page 2*

depleting ozone in the stratosphere. The chemical manufacturing industry will use hydrochlorofluorocarbons (HCFCs) and, later, hydrofluorocarbons (HFCs), in place of the CFCs. As CFCs are replaced by HCFCs and HFCs, TFA will be produced in the atmosphere. Adequate research on the environmental effects of TFA has not been done. In a study funded by one of the chemical manufacturers, the DuPont Corporation, Drs. Likens and Driscoll will determine the fate of TFA in soil plots, measuring how much TFA is retained in soil, how much becomes a part of soil water, and what is the uptake of the chemical by organisms.

Maintenance of the long-term data set that makes the Hubbard Brook program such an important one to the scientific community is the responsibility of Donald Buso. Mr. Buso, a colleague of and assistant to Dr. Likens, has been working at Hubbard Brook year-round since the mid-1970s. Now, as manager of field research, he oversees the collection of chemical data from precipitation, groundwater wells and streams as well as from Mirror Lake, which is adjacent to the Experimental Forest and flows into Hubbard Brook.

Scott Nolan has been assisting Institute scientists at HBES for 10 years, first as a research assistant for Mirror Lake studies and now as HBES housing facilities manager for Dr. Likens and research assistant to plant ecologist Dr. Gary Lovett. Drs. Lovett and Likens together with Mr. Nolan and Mr. Buso are studying the process of dry deposition — atmospheric particles and gases that are deposited on leaves, stems and other surfaces — and they collect data in three ways. First, they use the mass balance approach, comparing the chemistry of precipitation (input) to that of stream water (output) at the weir, and estimating the value for dry deposition by determining the difference, the result of rainstorms washing deposited particles off plant surfaces. Second, they collect rainwater at several sites, some in fields and others under trees; the chemical difference between the samples is, again, the input from dry deposition to leaves on the trees. Finally, using micrometeorological approaches, they trap gases and particles from dry air in a filter attached to a vacuum pump. Some of the chemical analyses are done in the Henrietta Kendall Towers Laboratory at Hubbard Brook, and some by research assistants in the IES analytical laboratories. Data from all three techniques are compared to arrive at the most complete picture possible of what is carried and deposited by the air.

In addition, Hubbard Brook is one of 50 sites in the National Dry Deposition Network, a nation-wide project for dry deposition measurement sponsored by the U.S. Environmental Protection Agency (EPA). Dr. Lovett and Mr. Nolan are in charge of data collection at two towers extending above the Hubbard Brook forest canopy. Each week, Mr. Nolan changes air filter packs and sends the samples to the EPA for comparison with air quality data from the other sites around the country.



*Gail Steinhart loads an IES truck with her sampling gear. In the background is the Henrietta Kendall Towers Laboratory, named in memory of a local resident who had been a friend of HBES scientists since the mid-1960s. The sign over the door was made by the late John S. Eaton, a forest ecologist who was data manager at HBES and manager of laboratory facilities at IES until 1988.*

Gail Steinhart, a graduate student of Dr. Likens, is a doctoral degree candidate at Cornell University's Section of Ecology and Systematics and at the Institute of Ecosystem Studies, with an interest in biogeochemistry and limnology (freshwater studies). Before starting graduate work she was a research assistant for the Institute's whole-lake experiments (see Vol. 9 No. 5 of the IES Newsletter). This summer, her first at Hubbard Brook, she is investigating aspects of denitrification, a naturally occurring process by which nitrate — a nitrogen compound used by plants for growth — is converted to nitrogen gas by bacteria. Under normal conditions, a portion of excess nitrate, a potential source of pollution, is broken down in this process. Some forests in the Northeast, especially in the Catskill and Adirondack Mountains, are beginning to show signs that they are receiving more nitrogen, from atmospheric deposition, than trees can use as nutrients or soil microbes can convert. Excess nitrate in these forests is leaching out of watersheds into lakes and reservoirs. (This is a

potential problem not only because of the increased likelihood of eutrophication but also because high concentrations of nitrate in drinking water can cause methemoglobinemia, blue-baby syndrome, in people.)

Much is still to be learned about the denitrification process. Ms. Steinhart is adapting existing procedures to learn how bacteria may be contributing to the process of denitrification in Bear Brook, a Hubbard Brook tributary that drains two of the experimental watersheds. She will be collecting stream sediments to find environments where denitrification is occurring, and also will be analyzing water samples for nitrate, ammonium (another form of nitrogen) and organic carbon. When she finds sites of denitrification, she will relate that information to existing watershed data, looking for a possible correlation with clearcutting and the resulting leaching of nitrogen from decomposing material to groundwater and streams.

Scientists return to Hubbard Brook year after year to collect data on projects that are made most meaningful by their long-term nature. Dr. Richard T. Holmes (Dartmouth College) and colleagues, for example, have been monitoring the bird populations at Hubbard Brook since 1969. During the 1980s they found the population size to be 50% less than in the previous decade, and currently they are investigating the possibility that long-term fluctuations of food resources may be one factor that affects bird numbers. During the Annual Cooperator's Meeting held each July at the U.S. Forest Service Headquarters at Hubbard Brook, approximately 150 scientists gather to report and discuss recent findings and current research.

\* \* \* \* \*

The Hubbard Brook Experimental Forest is one of the sites established around the world as part of the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Man and the Biosphere Program. The Biosphere Reserves were selected to preserve representative ecosystems and to provide opportunities for long-term multidisciplinary research on the effects of humans on the biosphere. The Hubbard Brook site is the only Biosphere Reserve representative of the northern hardwood forest ecosystem.

# IES Notes



CARL BELFUGLIO

• "... as the discoverer of acid rain in North America, you helped awaken the world to the concept that environmental problems are not local but are global in nature, and in doing so provided a model for ecological and biogeochemical studies worldwide." So began the citation read to Institute Director Dr. Gene E. Likens at the 47th commencement of Marist College (Poughkeepsie) when he received an honorary degree of Doctor of Science in recognition of his research with the Hubbard Brook Ecosystem Study (see story on page 1). L. to r.: Dr. Orin Lehman, New York State Commissioner of Parks, Recreation and Historic Preservation, who received an honorary degree of Doctor of Humane Letters; Dr. Likens; Dr. Dennis J. Murray, President of Marist College; James Earl Jones, actor, who received an honorary degree of Doctor of Fine Arts and who delivered the commencement address; and James A. Cannavino, Chairman of the Board of the Marist College Trustees.



CONWAY SCHOOL PHOTO

• Dr. Mark J. McDonnell (above), a terrestrial ecologist at the Institute, was the commencement speaker at the Conway School of Landscape Design in Conway, Mass. The mission of the Conway School is "to explore, develop, practice and teach design of land that is environmentally and ecologically sound". To learn more about

the Institute, with its similar philosophy, the class of 1993 visited IES last October. Accompanied by IES program leader in continuing education William S. Montgomery, a 1991 graduate of the Conway School, the students met with a number of Institute gardeners and scientists, including Dr. McDonnell. In his June 13 address, Dr. McDonnell congratulated the graduates for the good job they are doing in utilizing ecological information, and encouraged them to keep certain ideas in mind as they begin their new careers as landscape designers: 1) educate the public, managers and elected officials about the need for ecologically sound landscape design; 2) build bridges with other disciplines such as ecology, wildlife biology and sociology to develop design standards that will address both ecological constraints and human needs; and 3) use ecological common sense when developing plans and designs.

• Institute ecologists serve as judges at the Dutchess County Regional Science Fair, and, based on their interviews and observations, select a student to receive the IES Environmental Science and Ecology Award. The 1993 recipient was Bhakti Mirchandani, a freshman at John Jay High School in Fishkill, N.Y. whose population

genetics project involved an analysis of heritability of height in humans. Using a sample size of 500 classmates and their parents, she found that the heritability changed over time from recent immigrants to first-generation and second-generation Americans and so on. IES judges Gary Lovett, Richard Ostfeld, Josh Van Buskirk and Kathleen Weathers chose Ms. Mirchandani as the IES award winner in recognition of her use of the scientific method and her thorough understanding of her subject. At a ceremony at the Institute, Dr. Likens presented Ms. Mirchandani with a Certificate of Recognition and a \$50 award. Honorable Mention certificates were sent to Melissa Sullivan, a 7th grader at St. Denis/St. Colomba School (Hopewell Junction, N.Y.) for her project on the effect of car exhaust on seedling germination; and to Erica Keller, a 6th grader at Van Wyck Jr. High School (Wappingers Falls, N.Y.), who studied gerbil behavior.



TOM TAFT

Ms. Mirchandani and Dr. Likens

• Each summer since 1987 the Institute has sponsored a student for a week at Camp DeBruce in the Catskill Mountains. The students eligible for the opportunity are in classes that are using the IES Eco-Inquiry curriculum, and this year Jared Turner was selected by his 6th grade teacher at Pawling Elementary School, Ms. Carol Seem, for his interest in ecology. In a thank-you letter to Eco-Inquiry project coordinator Lisa Morganstern after his late-June stay at Camp DeBruce, Jared wrote "I had a great time and learned a lot about team work, the environment and other people." [Camp DeBruce is one of the New York State Dept. of Environmental Conservation's environmental education camps. The DEC encourages sponsorship of campers by environmental organizations, civic groups and others.]

## Congratulations to ...

... three IES graduate students who recently completed their doctoral studies:

- Martin Christ did his research as part of the Hubbard Brook Ecosystem Study (see page 1) and wrote his thesis on "Investigating the role of base cation and ammonium deposition in soil and soil-water acidification at the Hubbard Brook Experimental Forest, New Hampshire". Mr. Christ has accepted a position at the University of Illinois Department of Forestry.
- Richard V. Pouyat's thesis title was "Soil characteristics and litter dynamics in mixed deciduous forests along an urban-rural gradient". He is now a research forester with the U.S. Forest Service and a visiting scientist at the Institute.
- Kathleen C. Weathers explored "The effect of four landscape features on atmospheric deposition to Hunter Mountain, N.Y.", and completed her graduate studies while working full time at the Institute as manager of laboratory facilities. Ms. Weathers will continue in this position, and also will continue her research.

All three scientists did their graduate work at Rutgers University and IES. Martin Christ and Kathleen Weathers, who will receive their degrees at a ceremony on October 9, were students of Dr. Gene E. Likens. Dr. Pouyat was a student of Drs. Mark J. McDonnell and Steward T.A. Pickett.

### • • NOTE • •

The Gift and Plant Shop is now open on Monday, from 11 a.m. - 5 p.m. (closed from 1 - 1:30 p.m.)

## Calendar

### CONTINUING EDUCATION

Among the many courses, workshops and excursions offered during the first part of the **fall semester** are:

Sept. 13: **Ecological Landscape Design:**

**Successful Design with Native Plants**

Sept. 13: **Drawing I**

Sept. 21: **Basic Botany**

Sept. 21: **Botanical Watercolor Exploration**

Oct. 2: **Reflections of Nature: Japanese Design**

**Concepts**

Oct. 2: **Ecology and Earth History: The Taconic Highlands** (Excursion)

Oct. 16: **Ecologically Based Landscape Design for Professionals** (Workshop)

Oct. 16: **American Indian Healing Plants**

Oct. 17: **Ecologically Sound Landscape Planning for Homeowners** (Workshop)

Oct. 23: **How Landscapes Affect the Ecology of Lyme Disease** (Workshop)

Oct. 23: **Mianus River Gorge Wildlife Refuge & Botanical Preserve** (Excursion)

Oct. 30: **Careers with Landscapes and Gardens** (Workshop)

Visit or call the Gifford House (number below) for a free catalogue describing these and many other programs.

### IES SEMINARS

The Institute's program of **scientific seminars** features presentations by visiting scientists. Beginning in mid-September, free seminars are held each Friday at 3:30 p.m. in the Plant Science Building.

### SUNDAY ECOLOGY PROGRAMS

**Free public programs** are held on the first and third Sunday of each month, except over holiday weekends. Programs begin at 2 p.m. at the Gifford House on Route 44A unless otherwise noted. Call (914) 677-5359 to confirm the day's topic.

Sept. 19: **A Garden Story**, an activity for children and adults led by Diana Wilson

Oct. 3: **Monitoring the Environment — How? ... and Why ...**, a walk and demonstration led by Vicky Kelly

*For more information, call 914/677-5359 weekdays from 8:30 - 4:30.*

Oct. 17: **Small Mammals of New York Forests and Fields**, a walk and demonstration by Dr. Richard Ostfeld

- *In case of inclement weather, call 914/677-5358 after 1 p.m. to learn the status of the day's program. For outdoor programs, dress for the weather conditions, with long pants, socks and sturdy waterproof shoes.*

### GREENHOUSE

The IES greenhouse is a year-round tropical plant paradise as well as a site for controlled environmental research. The greenhouse is open until 4:00 p.m. daily except public holidays. Admission is by free permit from the Gifford House.

### GIFT SHOP

**Senior Citizens Days:** On Wednesdays, senior citizens receive a 10% discount (except sale items).

### ARBORETUM HOURS

**(Summer hours: May 1 - September 30; closed on public holidays)**

Arboretum grounds are open Mon. - Sat., 9 a.m. - 6 p.m.; Sun. 1 - 6 p.m. (**Note:** The Greenhouse and Plant Science Building close at 4 p.m.)

The **Gift and Plant Shop** is open Mon. - Sat., 11 a.m. - 5 p.m. and Sun. 1 - 5 p.m.

(Closed weekdays from 1 - 1:30 p.m.)

- *All visitors must pick up a free permit at the Gifford House Visitor and Education Center on Route 44A for access to the Arboretum. Permits are available until 5:00 p.m. daily.*

### MEMBERSHIP

Become a member of the Mary Flagler Cary Arboretum. Benefits include a member's rate for IES courses and excursions, a 10% discount on purchases from the Gift Shop and a free subscription to the IES Newsletter. Individual membership is \$30; family membership is \$40. For information on memberships, contact Janice Claiborne at (914) 677-5343.

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